Innovations for a Changing World

IBERS Impact Case Stories

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RESILIENT CROPS
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UKRI Biotechnology and Biological Sciences Research Council

Welcome to IBERS

Institute of Biological, Environmental & Rural Sciences

The world has a finite area of land to feed, fuel and clothe a growing population, while at the same time reducing greenhouse gas emissions and safeguarding biodiversity. With over a hundred year history of working to improve grassland agriculture, IBERS' research aims to make farming more productive, beneficial to society and protective of our environment.

At the institute, we conduct cutting-edge fundamental and applied research that underpins the breeding of new and improved varieties of crops, makes agriculture more sustainable, and enables industry to develop new processes and products.

In the heart of Wales, IBERS' unique location and ecosystem of capabilities allows our students and researchers to conduct hands-on research and training in plant genetics, agriculture, ecology, biotechnology, and environmental science. Enabling study of our environment, habitats, and food systems from summit to sea and field to fork.

IBERS core research is focused on making crops more resilient to climate change, improving crop quality, safeguarding genetic diversity, capturing carbon, and understanding the wider interactions between agriculture and the environment.

We work closely with industry to tackle global challenges, engage with policymakers and the wider agricultural community to better understand the critical issues, and then work collectively to find solutions. This collection of impact case stories provides some real-world examples of where IBERS has been, and is, creating impact by applying our bioscience to help build a better tomorrow.

Professor Iain Donnison,
IBERS Director

Case Stories

Economic Impacts

IBERS (Institute of Biological, Environmental and Rural Sciences) is a UK national capability in plant breeding and grassland science and one of eight strategic institutes supported by the BBSRC. It plays a key role in sustainable agriculture, environmental improvement, and economic growth & development.

Key Research Areas and Impacts

Forage Crops: Breeding of perennial ryegrass and clover for sustainable agriculture.

Grains & Cereals: Focus on oats and beans for healthier diets.

Biomass: Development of miscanthus for renewable energy and carbon reduction.

Crop Genomics: Tools to advance crop innovation and plant breeding.

Agricultural Systems: Multi species swards for agriculture and the environment.

Biorefining: Extracting valuable chemicals from biomass.

Research Infrastructure

Facilities include a Seed Bank, National Plant Phenomics Centre, Biorefining Centre, and experimental farms including Pwllpeiran Upland Research Platform.

Economic Impact (2017–2023)

In 2024, SQW provided an independent review of IBERS' economic and social impact for the period 2017-2023, highlights below:

- 300+ research projects: From large-scale breeding to applied research with UK and international partners.

Commercial Success:

- 50%+ of UK forage grass seed and over 90% of winter oats are IBERS varieties.
- Strong ties with leading agricultural and energy crop companies.

Support for SMEs:

- Helping start-ups validate innovations, attract funding, and launch new products in the bio-economy.

Broader Benefits:

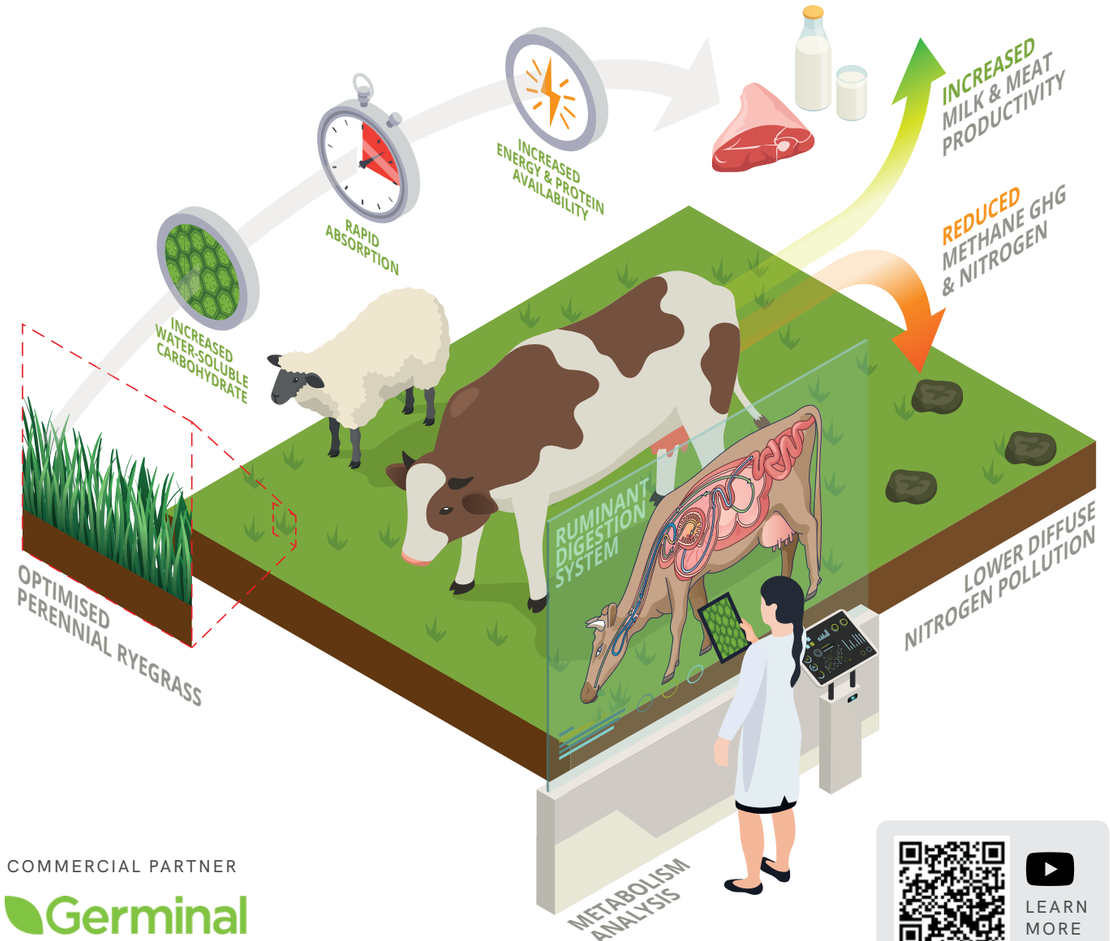
IBERS' activities generate impact:

- through supply chains from farmers who gain access to more options for land use,
- to consumers by enabling access to new, cheaper and higher quality products,
- and society overall which benefits from climate change adaptation and mitigation outcomes.

High Sugar Grasses

High sugar ryegrasses bred at IBERS have become a worldwide success story, renowned for their ability to improve livestock productivity while also reducing greenhouse gas emissions. Development of these transformational perennial ryegrasses began back in the 1980s. Based on a detailed understanding of plant carbohydrate biochemistry and the breakdown of grasses in the rumen of sheep and cattle, the research led to a revolution in the selective breeding of forage grasses to improve their quality. Scientists found that when livestock lack readily available energy sources (e.g. from water soluble carbohydrates commonly known as "sugars"), productivity is lower and there are higher outputs of nitrogen in faeces and urine which is bad for the environment. By understanding carbohydrate biochemistry and how plant metabolites are broken down in the rumen of an animal's stomach, plant breeders were able to identify genetic diversity in sugar accumulation in perennial ryegrass. This breakthrough led to the development of grasses with a higher soluble carbohydrate concentration. These high-sugar grass varieties (such as AberDart and AberMagic) were rapidly taken up by industry. Their use benefits farmers and the environment, through an increase in ruminant agriculture productivity and a reduction in diffuse nitrogen pollution and greenhouse gas emissions. These high sugar grass varieties are sold by IBERS' long-term commercial partners, Germinal, and are grown not only in the UK but also increasingly overseas.

High sugar grasses support better livestock productivity and environmental benefits



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Improved Oat Varieties

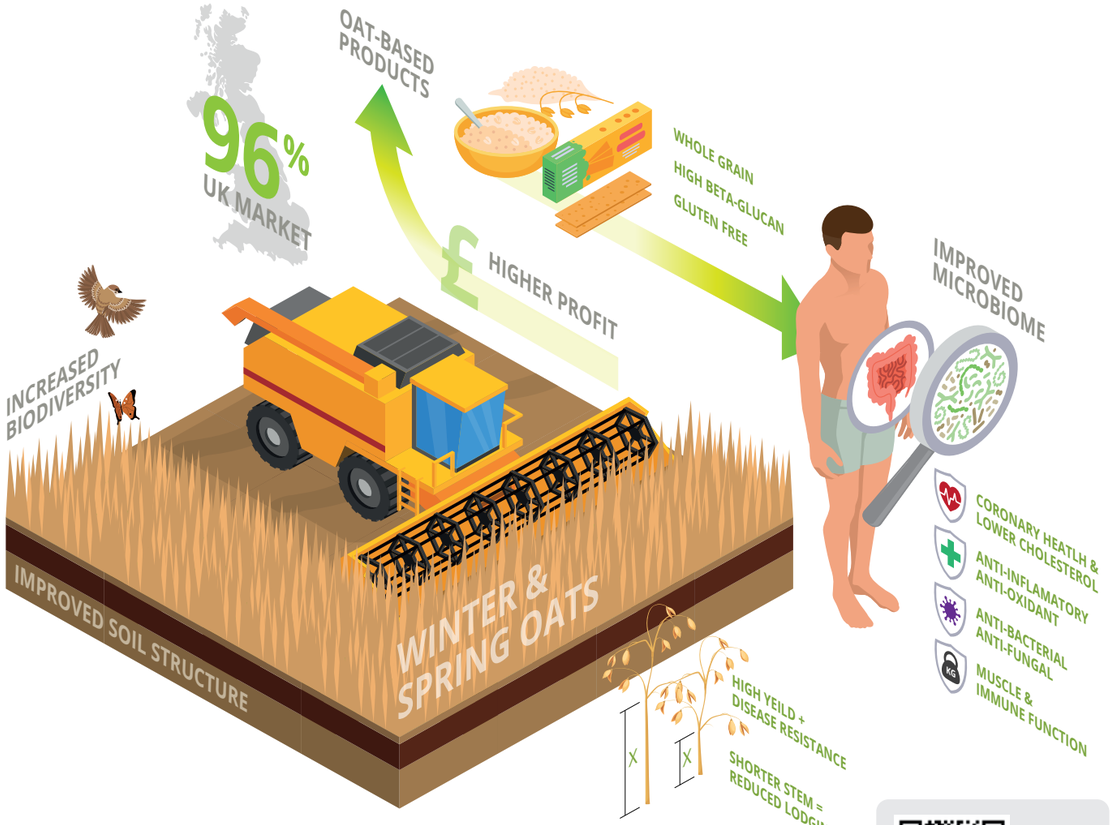
Over the past 25 years, the production of oats on farms in the United Kingdom has nearly doubled - thanks in no small part to varieties developed by IBERS with improved performance and milling quality. In 2024, varieties of winter oats bred at Aberystwyth University made up over 96% of the UK market. Our scientists have provided the genetic, physiological and agronomic knowledge that underpins the breeding of these high-yielding husked and naked oat varieties that meet the food needs of both people and animals.

One of the main reasons behind the increase in the demand for oats is their demonstrated health benefits and versatility when used in meals, drinks and snacks. Oats are eaten as a whole grain, are an excellent source of protein and fibre and do not contain gluten. Beta-glucan, a key dietary fibre in oat grains, has proven cholesterol-lowering and coronary health properties. Oats are also rich in other bioactive compounds, including the avenanthramides, polyphenols unique to oats that have anti-inflammatory and antioxidant effects, and the avenacosides, saponins with antibacterial and anti-fungal properties Additionally, it has been shown that oats benefit human health by enhancing immune function and improving gut microbiota. Oats also chime well with trends in consumer preferences for alternative protein sources to replace animal protein in food.

As a crop, oats provide wider environmental benefits, such as enhancing biodiversity in UK agriculture. They are an important break crop in crop rotations, helping to reduce disease pressure and improve soil structure, thus significantly enhancing sustainability in production systems. However, to further increase production, oats must produce economic returns similar to other cereals like wheat and barley, which are grown on a larger scale. Progress has included the development of shorter stemmed high yielding oats with a reduced risk of lodging in bad weather. When combined with oats' nutrient use efficiency and disease resistance, this is making oats a more sustainable and profitable crop.

New oat varieties are needed to meet the increasing demand for healthy food and to maintain crop diversity. There are five winter and three spring IBERS oat varieties on the 2024-25 AHDB recommended lists, marketed by our long-term commercial partners Senova. Ongoing work to increase the speed and precision of the oat breeding cycle is an integral part of IBERS' research programme, along with breeding varieties with enhanced grain quality and tolerance to drought, heat and water logging, which, over the longer term, could be beneficial for UK food security in a time of climate change.

Breeding new oat varieties with increased milling quality and human health benefits.



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senova

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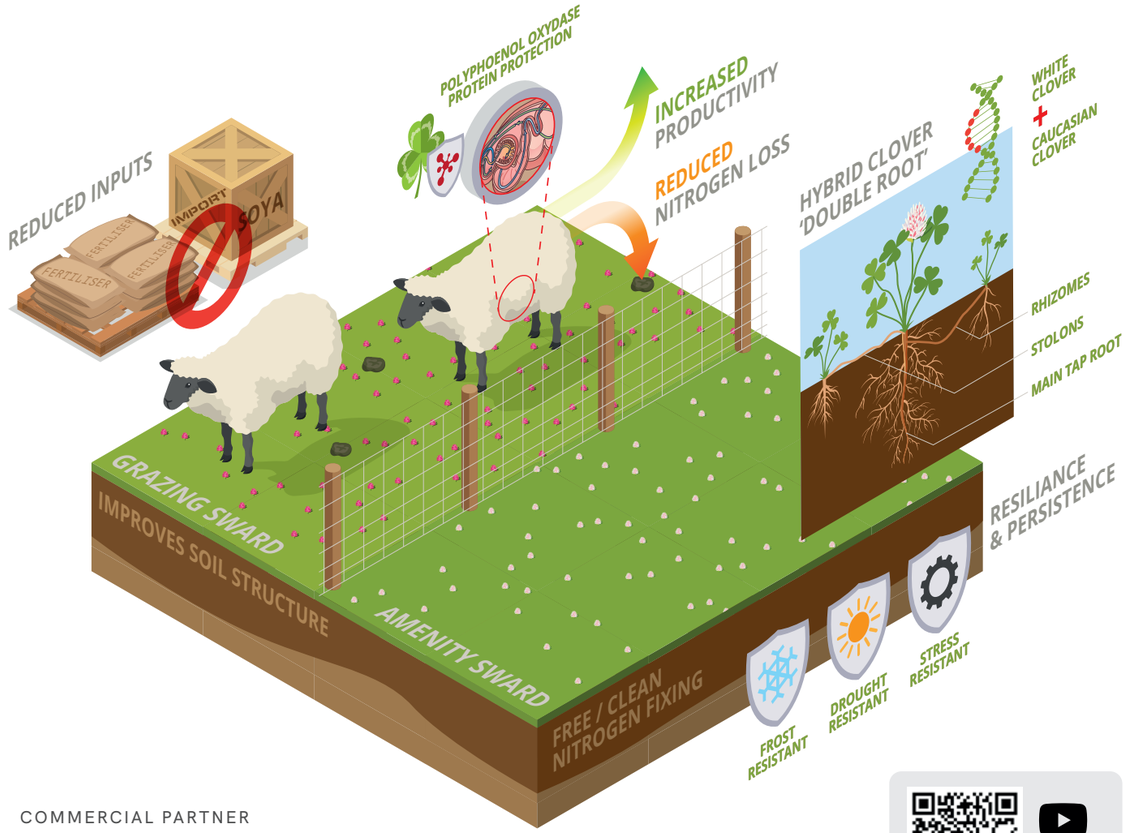
Persistent Clover Varieties

Red and white clovers can substantially improve the sustainability of livestock production as they reduce the need for manufactured inorganic fertilisers and offer a home-grown protein source as an alternative to imported soya. However, the use of clover has often been limited due to its poor persistence and resilience, either in a multi-species field (with white clover for grazing or silage making) or when grown as a monoculture (with red clover for cutting only).

Scientists at IBERS have managed to increase the persistence of red and white clover plant varieties in these agricultural systems. For example, white clover was crossed with Caucasian clover to combine stoloniferous and tap root formation in a single plant, providing more resilience and persistence. This was the first ever successful cross of its kind in the world and led to the development of AberLasting, a variety marketed as DoubleRoot by our industrial partner Germinal.

Traditionally, red clover has not capable of being grazed by livestock because of damage to the crown kills the plant. However, breeding a creeping form of red clover that can be grown in a field like white clover creates the option for livestock farmers to use red clover in a new way. Red clover contains an enzyme called polyphenol oxidase, which protects the protein in the rumen, leading to further improvements in the efficiency of livestock production as well as a reduction in nitrogen emissions. This new variety, which will be sold as RedRunner by Germinal, is undergoing national plant variety trialling for release in the near future and is again a world first for this crop, expected to transform grassland sward productivity.

Developing more persistent clover varieties to provide a sustainable protein source



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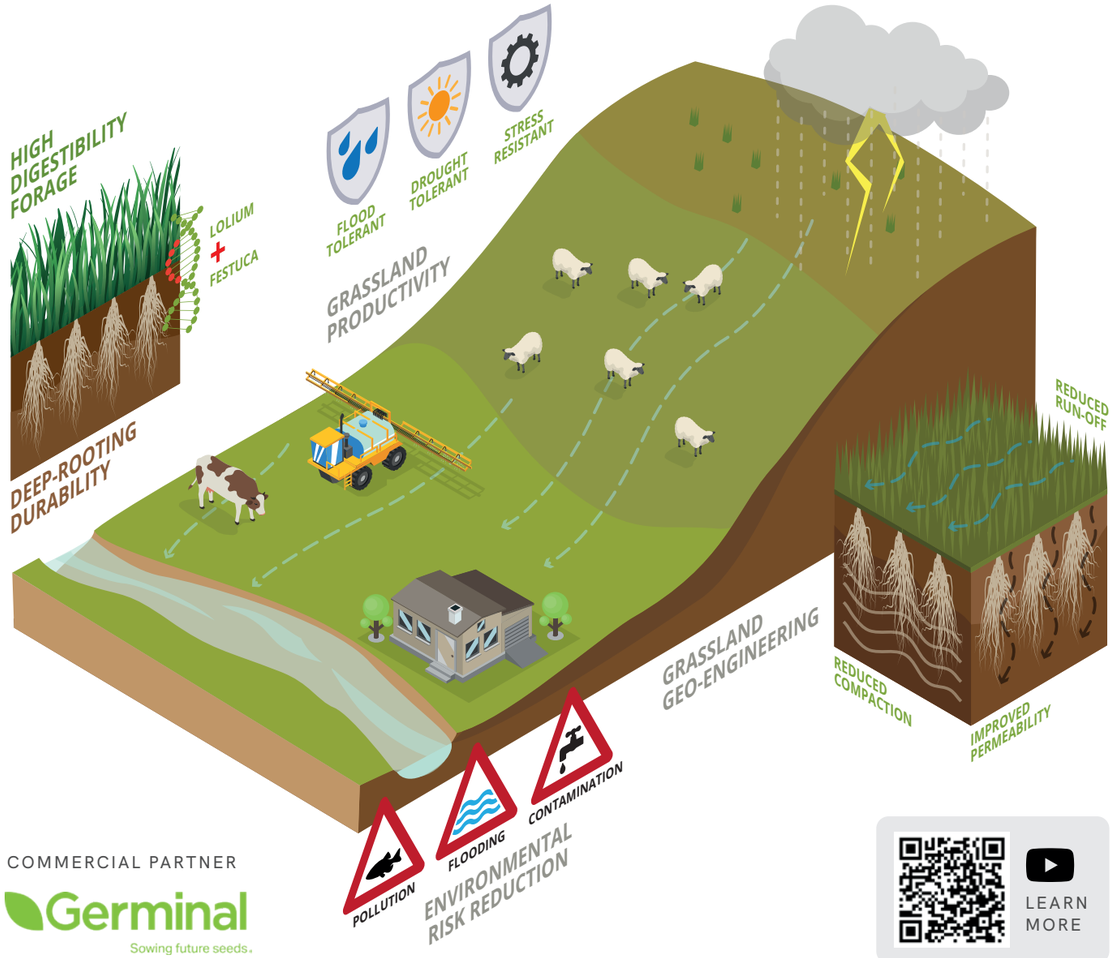
Deep-rooted Grasses

Climate change means UK grasslands are being affected more frequently by flooding and drought conditions. IBERS scientists have responded to the challenge by identifying advantageous root ideotypes with increased drought and flooding tolerance. Their research has drawn on their understanding of rooting behaviour in perennial forage grasses and related Festuca species. For example, grasses from north African Festuca species had a faster and deeper rooting phenotype, but they were not easy to digest and therefore not desirable as a forage grass.

Through crossbreeding with Festuca and chromosome painting techniques, our scientists have developed a more productive and digestible perennial ryegrass (*Lolium perenne*) and an Italian ryegrass (*Lolium multiflorum*).

These new varieties contain a small chromosome segment which had been introgressed by repeated crossing and selection. This modification has also led to increasing the rooting depth and root growth of the Festuca parent, resulting in the production of two new Festulolium varieties with increased resilience to drought and flooding - the AberNiche Italian ryegrass and the AberRoot perennial ryegrass. In addition, because these grasses have deeper rooting systems, soil compaction is reduced and soil porosity increased, which in turn reduces water and nutrient runoff from grasslands and, therefore, the risk of flooding and watercourse contamination. In other words, it has been possible to combine an increase in agricultural productivity and more local geoengineering to reduce environmental and societal risks from excessive nutrient and water runoff.

Developing deep-rooted grasses to increase grass resilience and reduce runoff/ flood risk



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Pearl Millet Improvements

More than 200 million of the world's poorest and most nutritionally insecure people are dependent upon pearl millet as their main dietary staple. Pearl millet not only has a low glycemic index but also has the added advantage of being a crop well suited to the arid uplands that do not support rice or wheat, It is therefore a crop with excellent food security credentials. However, climate change challenges even pearl millet production because of a combination of abiotic (drought and heat) and biotic (downy mildew fungus) stresses.

IBERS scientists have collaborated with partners in India and Africa to develop new varieties, based on molecular marker technology and field-based breeding. The aim is to increase drought tolerance in pearl millet, further expand the areas where it can be grown and improve the reliability of the harvest. Bred in 2005, this new variety is grown on more than 875,000 ha annually and provides smallholder farmers in India with an additional income of £7 million per year.

The focus of our latest research is on combining resilient pearl millet varieties with naturally occurring genetic variations of nutritional traits. This has led to the development of drought-tolerant pearl millet varieties with a low glycaemic index which can help control diet-related illnesses such as type-2 diabetes and obesity in sub-Saharan Africa and India. A first such hybrid combining low GI and drought adaption is being notified and released for cultivation across 15 countries in western Africa before the end of 2025. It is estimated that over three million smallholders in Africa will benefit economically from the development of this groundbreaking pearl millet hybrid as it will be a higher value cash crop as well as from the direct health advantages to farmers and their families.

Development of new varieties of pearl millet to increase drought resistance and improve human health in southeast Asia and sub-Saharan Africa

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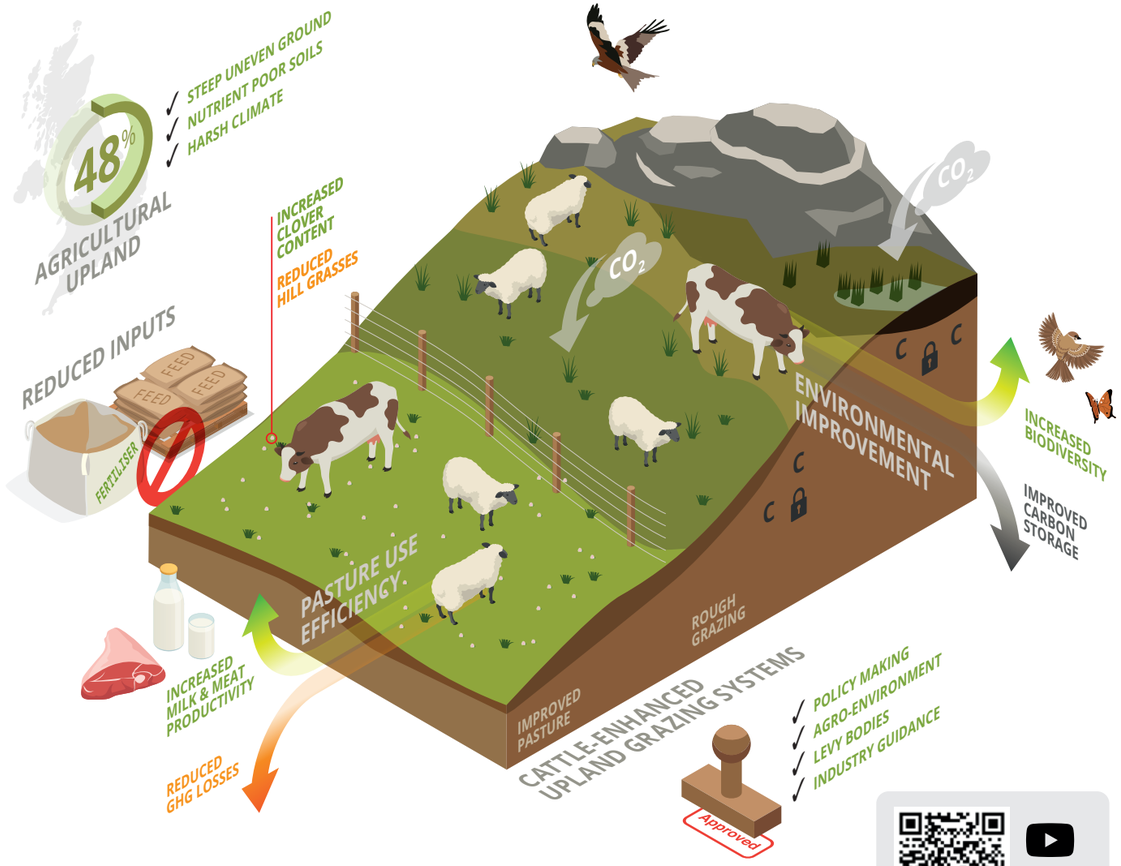
Upland Grazing Systems

Nearly half of the UK's agricultural land is classified as upland, characterised by natural handicaps such as nutrient-poor soils, steep slopes and harsh climatic conditions. These factors often mean that farming options are limited to grassland-based livestock production as the land is unsuitable for the cultivation of crops. Rearing livestock in these areas has advantages - offering additional food security while avoiding conflicts associated with the use of arable land to produce animal feed. IBERS has a team of researchers who are experts on making the most of this challenging land and have explored improving nutrient-use efficiency within upland grazing systems to increase productivity without additional feed or fertiliser inputs.

Our studies have shown that if sheep are grazed alongside cattle, the performance of the sheep is improved compared to sheep-only grazing, leading to a higher total output per unit area. This is mainly due to differences in their physiology being reflected in differences in grazing behaviour. Cattle are less selective feeders and will eat taller, stemmier patches avoided by sheep, leaving more nutritious plants such as clover. This leads to increased pasture use efficiency and higher growth rates for lambs, reducing intensities of methane emissions. Such benefits have been observed regardless of whether the sheep and cattle are grazed together (mixed grazed) or rotationally grazed (sheep following cattle). We have also shown that cattle grazing can effectively reduce the dominance of highly competitive hill grass species, thereby improving the habitat value of heathland communities of international conservation concern. Our research findings have been used to inform policy, agri-environment scheme development, levy body and industry guidance to farmers.

Improving the economic and environmental sustainability of upland grazing systems



Supporting Seaweed Research

The UK seaweed industry is a small, but rapidly growing sector; producing whole seaweed and extracts suitable for a wide range of products from food, animal feed and plant fertilisers to degradable plastics, gut probiotics and nutraceuticals. Combining experience and expertise at IBERS within seaweed composition and pilot-scale processing, we have aided the development of several UK seaweed companies through trials using our equipment.

These have arisen through several routes, from small research and development collaborations as part of European development and Welsh government funded projects; through contract research; to collaboration within InnovateUK grants. Whilst rising through the technology readiness levels, issues have been identified which are not seen when working at smaller (lab) scale; generating knowledge benefitting the company and IBERS1. Other industrial collaborations have occurred through research, for example, as PhD studentship sponsorships or within undergraduate projects.

More fundamental seaweed research also occurs, predominantly around the composition and effects of seaweed extracts or biostimulants on plants; but also in novel seaweed-degrading enzyme isolation, expression and characterisation; biodegradable plastics; the potential for seaweeds as alternative protein sources; and using extracts to improve gut health.

At larger, networking levels, IBERS staff have been involved with European COST action calls through training schools, workshops and review publications. Proposals are being developed with the aim of forming a UK seaweed network, led by staff at IBERS and a range of organisations, including the Scottish Seaweed Industry Association, University College London and Cefas. The Presidency of the British Phycological Society, the main UK algal society, will be held by IBERS staff between 2026-2027; with the annual meeting for this society also held in Aberystwyth in January 2026.

Supporting seaweed research and industry

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[1] Adams et al., 2021; doi.org/10.3390/jmse9101082

Scalable Miscanthus Biomass

The transition to a bioeconomy requires a sustainable source of plant biomass for green manufacturing (e.g. for the chemical, construction and steel industries) and alternative transport fuels (e.g. for road, shipping and aviation). Moreover, perennial biomass crops such as Miscanthus are needed as feedstocks for facilities which combine bioenergy with carbon capture and storage (BECCS) to help the UK meet net zero by 2050. The latest evidence is that BECCS as a means of removing carbon dioxide from the atmosphere is the best route for the UK to meet its targets, as the process of planting new forests would take longer to achieve the same greenhouse gas removal.

Though classed as a tropical grass, Miscanthus is an ideal biomass feedstock for the UK because it offers very high productivity levels alongside an ability to grow on more marginal land. On the one hand, it combines perenniality (so there's no need for annual ploughing and planting) with highly water and nutrient-efficient C4 photosynthesis (typically only found in tropical grasses that can't thrive under temperate conditions). On the other, it has a unique ability to grow in adverse environments, including low temperatures, drought and flooding. IBERS scientists have collected Miscanthus germplasm from a diversity of environments and, through a combination of trait biology and crossing, have produced a range of new varieties, suited to the UK climate and beyond.

Concurrent work has included sequencing the complex Miscanthus genome and developing the agronomy for this new perennial biomass crop. Important breakthroughs include the development of genomic selection, speed breeding, and seed-based propagation to accelerate the breeding cycle, diversify the crop and enable us to scale up production more rapidly. While crops such as wheat and maize were typically domesticated over millennia, this modern development of a new crop from the wild, undertaken in line with the UN's Nagoya protocol, has taken only 20 years. The Miscanthus improvement program at IBERS has resulted in the world's first Miscanthus varieties (seven in total) registered for biomass use and these are licensed to industrial partner Terravesta for commercialisation.

Domestication of Miscanthus as a new crop to help the UK reach net zero

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Sustainable Sweeteners

ARCITEKBio Ltd., a cleantech company spun out of research at IBERS, aims to revolutionise the production of natural sweeteners. Using innovative biotechnology similar to brewing, ARCITEKBio transforms agricultural straws into xylitol. This sustainable and environmentally friendly natural sugar supports dental health and has a low glycaemic index, 40% fewer calories than table sugar with the same sweetness.

The Challenge: Traditional xylitol production relies on chemical processes that require toxic catalysts and high temperatures and generate significant effluent waste. This method contributes to greenhouse gas emissions and environmental degradation. Additionally, agricultural by-products like the fibre left over from sugar production (sugarcane bagasse) and cereal straws from wheat, oats and others are often underutilised, leading to waste and missed opportunities for value creation.

The Solution: ARCITEKBio's proprietary fermentation process uses yeast to convert C5 sugars (xylose) in agricultural by-products into xylitol. This brewing-like bio-manufacturing platform is feedstock-independent, requires no pre-cleanup or detoxification, and achieves competitive yields and purity. By utilising waste streams from industries such as paper and pulp manufacturing and agriculture, ARCITEKBio supports a circular economy and reduces the environmental footprint of sweetener production.

Impact: ARCITEKBio's product and sustainable production process have a significant health and environmental impact by lowering greenhouse gas emissions and energy requirements compared to traditional methods. By converting waste into valuable products, ARCITEKBio reduces landfill waste and promotes resource efficiency. The innovative process adds value to agricultural by-products, providing new revenue streams for farmers by developing a sustainable value chain for xylitol production, leading to skilled employment in rural communities. Xylitol, a natural sweetener with fewer calories than sugar, offers benefits for dental and diabetic health, and this process ensures a high-quality, sustainable product that meets consumer demand for healthier alternatives.

Future Directions: Having developed their process to pilot-scale at the IBERS Biorefining Centre in AberInnovation, ARCITEKBio are now moving to scale up this technology for commercial use. They aim to use European large-scale biorefining facilities capable of handling vast amounts of agricultural waste to demonstrate cost-effectiveness and refine the final product's taste, smell, and appearance to meet business-to-business and consumer preferences. Further research will focus on intensifying the fermentation process and exploring additional applications for the technology.

Conclusion: ARCITEKBio Ltd. demonstrates the potential of biotechnology to address global challenges in food production and environmental sustainability. By transforming agricultural waste into a valuable sweetener, this innovative approach supports a circular economy, reduces environmental impact, and enhances global food security.

Sustainable sweetener production through innovative biotechnology

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ARCITEKBio Limited

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Bread Waste to Protein

Bread waste is a significant global issue, with around 10% of the 185 million tonnes of bread baked annually discarded. This waste, primarily from supermarkets and commercial bakers, contributes to environmental burdens, mainly through greenhouse gas emissions from wheat farming and the disposal of uneaten bread. Our recent research offers a promising solution by transforming bread crusts into new foods using fungal fermentation, traditionally employed in Asia to produce plant-based proteins.

Our study uses solid-state fermentation with an edible fungus to convert bread crusts and grass protein, typically used for livestock feed in the UK and global agriculture, into a vegetarian alternative food. This process increases protein content and the ratio of essential amino acids and improves taste by removing the typical 'grass flavour' associated with grass protein. Grass protein, rich in nutrients, complements bread waste in this innovative process, resulting in an environmentally friendly and nutritionally enhanced food source.

IBERS scientists' approach addresses food waste and security challenges, offering a sustainable way to keep surplus bread and non-conventional plant protein in the food chain. By supporting a circular economy, our fermentation process has the potential to reduce landfill waste and lower greenhouse gas emissions significantly.

We are now working on scaling up this process for commercial use, collaborating with industry partners to create facilities capable of handling the large-scale production of this product.

Further research will ensure cost-effectiveness and refine the final products' taste, smell, and texture to meet consumer preferences.

This innovative approach could enhance global food security and sustainability in the long run. By turning bread waste into a nutritious food source, our study tackles a major environmental issue and paves the way for a more sustainable future. Our research demonstrates how fermentation can unlock the hidden potential of food waste, revolutionising how we think about surplus bread when combined with sustainable protein from grass.

Transforming bread waste into sustainable protein: A fungal fermentation approach to enhance food security and reduce environmental impact

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SAMWORTH BROTHERS

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IBERS Distance Learning

IBERS Distance Learning at Aberystwyth University supports UK-based and international professionals working in agriculture, food, and emerging bioeconomy sectors. Originally launched in 2011 as part of the BBSRC-funded Advanced Training Partnership, the programme was designed to bridge the gap between agricultural research and practice – encouraging innovation and sustainability on-farm. That mission remains at the heart of what we do.

Delivered entirely online, the programme offers flexible, postgraduate-level study that fits around work and family life. Students can choose from a wide range of subjects—initially focused on pasture-based systems but now expanded to include biotechnology, food processing, circular economy, and digital agriculture. The provision ranges from individual modules (many with BASIS CPD points), postgraduate certificates and diplomas, MScs, MRes, and even a professional doctorate. Modules operate on a 'pay-as-you-go' basis, allowing learners to build up qualifications.

Our students include agri-advisors, vets, technical specialists, lecturers, and forward-thinking farmers. Most are qualified to degree level or higher, though others, without any formal qualifications bring extensive practical experience. The average age is 41, with a balanced gender mix. Last year, 90% of students were already working in the agri-food sector, with others aiming to transition into it. The cohort included 10 Nuffield Scholars and 10 learners from the Global South, including Commonwealth Scholars.

We are also active in global CPD via FutureLearn, where our short courses (e.g. Life Cycle Assessment) have reached learners in 123 countries. Another recent example of our work includes the Green Digital Skills programme with Powys County Council, supporting the upskilling of those in rural sectors with tools such as programming, robotics, and circular economy principles. IBERS learners are influencers. The knowledge they gain is cascaded widely – through advice, training, policy, research and business – magnifying the impact of every module we deliver.

IBERS Distance Learning: Upskilling the Agri-Food Workforce

National Plant Phenomics Centre

IBERS hosts the National Plant Phenomics Centre (NPPC), an automated system for non-invasive longitudinal phenotyping for up to 3,400 individual plants. The NPPC allows populations of crops, and other plants, to be assessed by non-invasive imaging technologies to record shoot growth and development, water content, photosynthetic activity, temperature and root development.

For more information visit:
plant-phenomics.ac.uk
or **01970 823229**

IBERS Distance Learning

IBERS distance learning offers a range of training opportunities to develop skills and gain qualifications relating to the Agrifood sector. Providing flexible courses for those already working in the sector or looking to start a new career.

For more information visit:
ibersdl.org.uk

Contact: **01970 823244**
dl-enquiries@aber.ac.uk

IBERS Knowledge Exchange Hub

IBERS Knowledge Exchange Hub collaborates with Welsh Government through the Farming Connect and Lantra to facilitate the exchange of scientific research across the Welsh agricultural and forestry sectors.

Contact: **01970 823137**
kehubfc@aber.ac.uk

Biomass Connect aims to support the development of the biomass industry

Contact: **01970 823136**
aac@aber.ac.uk

Aber Innovation

Providing support for businesses seeking to develop new products and processes in the agri-tech, food, drink and bio-economy sectors.

For more information visit:
aberinnovation.com

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IBERS is a BBSRC strategically funded Institute, and a National Capability in Grassland and Plant Breeding Science.

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